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The Effects of Control and Uncertainty on Children's Supernatural Beliefs

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The Effects of Control and Uncertainty on Children's Supernatural Beliefs

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Dedication

This work is dedicated to my mother, Dee Ann Cornelius, whose untimely death piqued my interest in children's supernatural beliefs.

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The Effects of Control and Uncertainty on Children's Supernatural Beliefs

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Most people believe that the world is orderly and predictable, and one mechanism by which this belief is maintained is a sense of personal control, or the belief that one can predict and steer outcomes. Research indicates that when adults perceive a threat to their personal control, they will compensate for this threat by seeking other sources of control. However, it is unclear whether children also feel threatened by a lack of personal control or whether they seek similar sources of compensatory control as adults. The proposed studies investigated the process of compensatory control in children. A novel game primed children to feel either high personal control or low personal control in order to evaluate the extent to which children seek compensatory control via 1) the detection of visual patterns in random noise, 2) endorsement of superstitious explanations for events, and 3) explicit belief in supernatural sources of control. Children also completed a questionnaire designed to measure their intolerance of uncertainty. It was predicted that both the manipulation of control and individual differences in children's willingness to tolerate uncertainty would affect compensatory control seeking behaviors. Results indicated that manipulation of personal control did not affect children's pattern detection;

however, the manipulation did affect children's endorsement of karma-like explanations, such that children in the low-control condition were significantly more likely to endorse such explanations compared to children in the high-control condition. Regarding individual differences, results indicated a positive relationship between children's intolerance of uncertainty and their explicit belief in God. These results are interpreted with regard to existing research with adults, and the implications for situational and dispositional motivations for control are discussed.

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Introduction

"As nature abhors a vacuum, so does human nature abhor randomness. We prefer order over chaos, harmony over cacophony, and religion over the prospect of an arbitrary world." – Vyse, 1997

A basic human motivation is to understand, predict, and maintain a sense of control over our environment. However, sometimes we encounter events that threaten our sense of control, and we experience such events as psychologically aversive. Research indicates that when adults perceive a threat to their personal control, they are motivated to seek external sources of control in order to compensate (Kay, Whitson, Gaucher, & Galinsky, 2009). Like personal control, these sources of compensatory control serve to preserve a sense of order and avoid the anxiety associated with the possibility that life's events are subject to randomness and thus outside the realm of personal control. Examples of compensatory control-seeking behaviors include detecting patterns in random stimuli (Whitson & Galinsky, 2008), engaging in ritualistic or superstitious behavior (Keinan, 2002), and believing in nonmaterial sources of control, such as God (Laurin, Kay, & Moscovitch, 2008). According to the model of compensatory control (Kay et al., 2009), these various behaviors help maintain a belief in a nonrandom world, or a belief that things are generally in control even in the absence of personal control.

This dissertation is an investigation of the development of the compensatory control process in children. Specifically, it addresses whether children perceive a lack of control as threatening and whether a lack of control motivates them to seek similar

sources of compensatory control as adults. In the literature review, I first define personal control, describe why a lack of control is psychologically aversive, and summarize research that reveals our misconceptions about personal control and randomness. Then, I review evidence that supports our motivation to seek sources of compensatory control when our personal control is threatened and present findings that indicate that individuals differ in the extent to which they are motivated to seek control. Next, I provide the details of my experiments, including the methodology used to assess the effects of lack of control and uncertainty tolerance on children's use of compensatory control. Following each experiment, I present the results and discuss the findings. The final chapter serves as a general discussion.

Literature Review

PERSONAL CONTROL

A useful place to begin is with a description of personal control and the function it serves. Kay et al. (2009) define personal control as "an individual's belief that he or she can personally predict, affect, and steer events in the present and future" (p.264). According to these researchers, personal control is one mechanism by which we reduce uncertainty and maintain the view that the world is orderly and predictable. In other words, personal control is not an end in itself; rather it is a means of preserving the belief that the world is not random.

Effects of Having and Lacking Personal Control

A long history of theoretical and empirical research demonstrates that control plays a crucial role in human psychology. Not only are we are motivated to maintain control throughout the lifespan (Heckhausen & Schulz, 1995), but a sense of control has been associated with better physical health (Shapiro & Astin, 1998), more self-efficacy (Bandura, 1977), and adaptive adjustment to adversity (Taylor & Armor, 2006). On the other hand, feeling a lack of control can result in hopelessness and depression (Prociuk, Breen, & Lussier, 1976), stress and anxiety (Moulding & Kyrios, 2006), as well as fear (Mineka & Kelly, 1989).

One of the most striking examples of the effect of personal control on psychological wellbeing comes from a field study conducted in 1976 by Langer and Rodin. As part of an intervention, elderly residents in an experimental group listened to a speech that emphasized their personal responsibility, whereas residents in a control group listened to a speech that emphasized the staff's responsibility toward the residents. Also, the experimental group was given the choice to take care of a houseplant, while residents

in the control group had their plants maintained by the staff. After only three weeks, results indicated that the experimental group scored higher on measures of alertness, active participation, positive mood, and sociability. Moreover, a follow-up study conducted 18 months later revealed that those who were given more personal control were not only healthier than they were before the intervention, but they were also more likely to be alive compared to those in the control condition (Rodin & Langer, 1977).

If the function of personal control is to help us feel that we can predict and understand our world, it is easy to see why we are motivated to believe that the world is not random. After all, the word random is typically defined as "having no definite aim or purpose; haphazard" (Oxford English Dictionary). Interestingly, research suggests that we not only perceive randomness as a threat to our personal control, but we also have various misconceptions about the nature of randomness and our ability to predict it. The following sections describe children's and adult's understanding of randomness.

Children's Understanding of Randomness

Piaget and Inhelder (1975) were the first to systematically investigate children's understanding of chance and randomness. In their study, children aged 4 to 12 years were shown a shallow box that rested on a pivot point (similar to a seesaw), and along the width of the box were eight red marbles followed by eight white marbles. Children were asked to predict the movement of the marbles as the box moved from one side to the other, and these predictions were used to categorize children into one of three stages. Children aged 4 to 7 were typically categorized in the first stage of chance understanding. These children often referred to an underlying order or uniformity, and their predictions about future movements of the marbles relied on past observations. Not until stage two, between the ages of 7 and 11, did children begin to formulate the idea of chance, as

measured by their understanding of the impossibility of foreseeing future random events. When children fully demonstrated comprehension of randomness, usually between the ages of 11 and 12 years, they were said to be in the final stage of understanding. Not only did the predictions of this age group reflect an understanding of the random nature of marbles' movements, but Piaget and Inhelder also concluded that children in this stage understand that increased repetitions will lead to a more stable distribution of outcomes, known as the law of large numbers.

However, more recent research suggests that even older children's understanding of randomness has its shortcomings. For example, a study by Metz (1998) demonstrated that third graders (8- and 9-year-olds) are susceptible to attributing determinacy to an apparatus that produces random outcomes. In one task, kindergarteners and third graders played a board game that entailed flicking a spinner that could land on one of four colors taking up various areas of the spinner. Older children differed from younger children in their understanding that the outcomes were proportional to the relative area of the colors on the spinner; however, children of both age groups failed to appreciate the indeterminacy of each spin and the uncertainty that should accompany indeterminacy. This suggests that Piaget may have overestimated older children's understanding of randomness.

Understanding the independence of random events is especially difficult for children when they are asked to make predictions in the face of past outcomes. For example, Ridgway and Ridgway (2010) engaged children aged 6 to 12 years in a task that involved estimating the outcomes of coin flips. On the first trial, children were asked to consider a coin flip and report whether heads was more likely, whether tails was more likely, or whether the outcomes were equally likely. On subsequent trials, participants were asked to consider a series of outcomes (e.g., heads, tails, heads, tails) and then

report whether heads was more likely to appear next, whether tails was more likely, or whether the outcomes were equally likely. Results indicated that among those who acknowledged that the two outcomes had an equal probability in the case of the single coin flip, nearly 50% of those children failed to generalize this reasoning to other trials in which a pattern of outcomes had first been established. Thus, it seems that children as old as 12 years continue to struggle with the concept of randomness, especially when asked to make predictions.

Research also indicates that children exhibit what Langer (1975) coined as an "illusion of control," or the notion that personal attributes can affect chance outcomes. In one study (Weisz, 1980), 5- to 6-year-olds and 9- to 10-year-olds predicted the success of various pairs of children participating in a game in which they attempted to draw cards with yellow dots from a deck said to contain both blue- and yellow-dotted cards. Compared to older children, younger children were more likely to predict greater success for a smart child and for a child who was allowed to practice. However, a significant proportion of both younger and older children responded that a child who was careful and tried hard would be more successful than a child who did not try very hard. That is to say, all children erroneously attributed the success of drawing the yellow cards as contingent upon the effort of doing so.

Recent work by Cornelius and Woolley (2014) indicates that children's success in a game of chance also breeds an illusion of control. Children ages 5 and 8 played a guessing game that involved dropping a marble into the top of a box and predicting from which of two doors at the bottom of the box the marble would exit. Unbeknownst to the participants, the experimenter controlled the marble's movements to ensure that some participants experienced success and others experienced failure. For each trial, participants were asked to provide an explanation for their prediction and rate their level

of certainty that their prediction would be correct. Children exhibited an illusion of control in their explanations, such as stating that they knew how to drop the marble in a particular way to make it exit the predicted door. They also revealed their illusory sense of control in their certainty ratings. Specifically, as the game progressed, children who experienced more success became more confident in their ability to make correct predictions. This behavior illustrates a misconception known as "hot hand," or the belief that success increases the likelihood of future success.

In sum, children begin to demonstrate a nascent understanding of randomness between the ages of 7 and 12; nonetheless, children in this age group continue to exhibit misconceptions about the extent to which they can control and accurately predict random outcomes. As the next section will illustrate, adults have similar misconceptions.

Adults' Understanding of Randomness

Research with adults suggests that fully understanding how randomness operates may not be a developmental milestone after all. For example, research by Tversky and Kahneman (1971) reveals that even professional psychologists hold misconceptions about probability, such as the erroneous assumption that random samples should resemble the underlying population, known as belief in the law of small numbers. This erroneous belief that small, random samples should resemble the underlying population is thought to be the cause of the well-documented gambler's fallacy, as demonstrated when someone predicts that a coin flip is more likely to come up tails after witnessing three heads in a row (Croson & Sundali, 2005). Such a prediction is inaccurate because the outcomes of coin flips are independent and identically distributed, such that the probability of tails is no more or no less than .50 on any given trial, regardless of whether the previous trials have been heads.

The gambler's fallacy has also been documented in adults outside the laboratory. For example, empirical data from casinos reveals that players of roulette demonstrate the gambler's fallacy when they place a bet for red after observing the roulette wheel consecutively land on black for five or more trials. In lottery games, the gambler's fallacy is observed when players bet less money on those numbers that were winning numbers in the previous drawing (Terrell, 1994).

Adults also exhibit fallacies with regard to the perceived effects of personal attributes on chance outcomes. Langer (1975) identified factors specific to skill-related tasks which, when incorporated into chance-determined tasks, produce an illusion of control. In a series of studies involving chance games (e.g., lottery and drawing cards), Langer found that adults' confidence in winning a chance game changed as a function of their familiarity with the stimulus, amount of practice, choice, and active involvement, which led her to conclude that although "people may pay lip service to the concept of chance, they behave as though chance events are subject to control" (p.311). The following section will address other ways in which we behave as though events are subject to control.

COMPENSATORY CONTROL

The previous section demonstrated how children and adults misinterpret random events as being subject to personal control. When an event cannot be interpreted as subject to personal control, the resulting unpredictability is unsettling, and people are motivated to compensate for this lack of personal control by engaging in behaviors that help maintain the belief that the world is predictable rather than random. In their proposal of this compensatory control process, Kay et al. (2009) suggest a few behaviors that may serve the function of acquiring compensatory control. One source of compensatory

control is the perception of illusory patterns. As defined by Whitson and Galinsky (2008), illusory pattern perception entails "the identification of a coherent and meaningful interrelationship among a set of random or unrelated stimuli" (p.115). In this sense, illusory pattern perception can refer to a variety of phenomena, such as visually detecting objects in random noise, as well as inferring that some behavior or object is causally related to an event. Another way that people compensate for a lack of personal control is by affirming their belief in nonmaterial sources of control, such as God (Kay et al., 2009). The following sections highlight research that demonstrates how threats to personal control are associated with visual pattern perception, endorsement of superstition, and explicit belief in nonmaterial sources of control.

Visual Pattern Perception: Findings with Adults

Although there are no developmental studies that directly assess the effect of lack of control on basic pattern perception, research indicates that children as young as 4 years can learn how to detect patterns (Papic, Mulligan, & Mitchelmore, 2011). For instance, after a 6-month intervention aimed to teach preschoolers about spatial patterns, results indicated that children in the experimental group demonstrated a greater understanding of what constituted a "unit of repeat," as measured by their superior ability to extend patterns compared to a control group. Moreover, mathematics curricula during the early school years maintain that children's ability to recognize visual patterns in the environment is an important precursor to algebraic thinking (McGarvey, 2012).

Indirect evidence from Cornelius and Woolley (2014) suggests that priming children to feel a lack of control can increase the perception of patterned outcomes. During the aforementioned game in which children predicted the movement of a marble through a box, children who experienced a lack of control in the form of incorrect

predictions were more likely to spontaneously generate hypotheses about how the outcomes were patterned. For example, upon observing the marble exit the right door on the first trial and the left door on the second trial, one child predicted that the marble would continue exiting the doors in an alternating fashion. However, after observing the marble exit the left door on the third trial, the child concluded that the box must follow a "right, left, left" pattern instead. Interestingly, many children continued to maintain that the outcomes were patterned, even after having up to four of their predicted patterns disconfirmed. Unlike the successful children who exhibited an illusion of personal control, unsuccessful children were motivated to determine an underlying order to the marble's random movements and hence "detected" patterns that were not really present.

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Endorsement of Superstition: Findings with Adults

Superstition can include a wide variety of behaviors, but behind all superstitious behavior is an unjustified belief in causation. Levinson (1963) defined superstition as any belief that "indicates as 'cause' and 'effect' pairs of events between which is seriously insufficient logical linkage." Thus, superstition can include the belief that a particular action can cause an event (e.g., crossing one's fingers), and the belief that an object can bring good fortune (e.g., a four-leafed clover). Superstitious belief is surprisingly prevalent among the general population (Vyse, 1997). For example, 63% of American adults report having at least one superstition, and 72% say they have at least one good luck charm (Epstein, 1993).

One contextual factor that is related to superstition is the need for control in times of uncertainty. In one study, Whitson and Galinsky (2008) demonstrated that priming participants with either high personal control or low personal control affected their judgments about the efficacy of superstitious behaviors. Half of participants were

instructed to recall an autobiographical experience when they had control over a situation, while the other half recalled an experience when they lacked control. Then participants read vignettes in which the main character experienced an event that was preceded by a potentially irrelevant behavior (e.g., a businessman getting ignored at a meeting after failing to stomp his feet three times before walking in the door). Participants rated the extent to which they perceived the action to be connected to the event. Results indicated that participants in the low-control condition perceived a greater degree of connection between the character's action and the event compared to participants in the high-control condition, and they also reported more motivation to perform the superstitious behaviors themselves in the future. This illustrates how a need for personal control can motivate superstitious behavior.

Legare and Souza (2014) have also demonstrated that priming randomness increases the perceived efficacy of superstitious behavior. For these studies, researchers created various rituals, defined as "causally opaque procedures," and paired these rituals with specific ailments. These novel superstitions were said to be remedies for unwanted conditions. As an example, one ritual read, "For five days, the person with depression should go to a crossroad. While there, the person should say, 'Depression, stay here!' The person should not walk through the crossroad for one year." Using a scramble sentence task in which participants are given a list of words and asked to make a sentence, half of the participants were primed with words relating to randomness (e.g., haphazardly, chance) and half of the participants were primed with negative words (e.g., slimy, idiotic). Results indicated that participants who received the randomness prime rated the superstitious behaviors as more effective than those who did not receive the randomness prime. The authors conclude that superstitious behavior serves to maintain an illusion of control and increase one's sense of predictability, especially in times of uncertainty.

Moreover, these results support the notion that priming randomness can activate biases to link two actions or events that are not causally related.

Endorsement of Superstition: Findings with Children

Piaget (1929) was the first to describe children's superstitious beliefs. He used the term "magic by participation" to refer to children's belief in a causal relationship between unrelated people, objects, or events. For example, the belief that some action could bring about a positive or negative event was referred to as "magic by participation between actions and things." Piaget believed that this form of magical thinking occurred because children confused the action for the actual cause of the event, and he maintained that beliefs in magical causation decreased with age, as children became increasingly more logical in their thinking.

In their book, *The Lore and Language of School Children*, Opie and Opie (1959) documented a comprehensive collection of childhood rituals and superstitions. Some examples included superstitious sayings (e.g., "step on a crack, you'll break your mother's back"), ideas about how to improve the efficacy of wishing (e.g., one must blow all the birthday candles out in one breath in order for the wish to come true), considering simultaneous speech by two people to be a jinx, and the belief that seeing a rare object could bring good fortune. Children also reported the use of good luck charms as a way to improve their performance in school and in games.

Other evidence that children will engage in superstitious behavior comes from early research designed to replicate Skinner's original work (1948) that suggested superstitions arise from operant conditioning. In one study, Wagner and Morris (1987) invited 3- to 6-year-olds to play a game with a toy clown, Bobo, that dispensed marbles that the children could later trade in for a highly desired toy. Bobo was programmed to

dispense the marbles on a fixed schedule, but over the course of six, eight-minute sessions, 75% of children developed sequences of behaviors that they performed repetitively, as if they believed their actions caused Bobo to dispense the marbles.

Only recently have researchers replicated the finding that children will engage in superstitious behavior in a lab setting (Sheehan, VanReet, & Bloom, 2012). In this study, a sensory superstition paradigm was used that involved the display of icons on a touch screen monitor. Children aged 3 to 5 first completed practice trials in which their taps on the screen were reinforced with a smiley face icon. Next, children were told that sometimes they needed to tap the screen many times to make the smiley face appear. On half of the test trials, a butterfly icon was displayed that had no relation to children's taps or to the display of the smiley face. Results indicated that children's rate of tapping was greater when the butterfly was displayed versus when no stimulus was displayed, suggesting that children associated the presentation of the butterfly with an upcoming presentation of the smiley face, even though the two icons were unrelated. Interestingly, no age differences were found, indicating that 3-year-olds were just as likely as 5-year-olds to engage in this form of superstitious behavior.

Although the traditional view in developmental psychology for a long time was that children were more prone to magical thinking than adults, recent evidence suggests that children may in fact be less likely to endorse beliefs in supernatural causation than adults. In one study, Legare and Gelman (2008) examined bewitchment beliefs among children and adults in Sesotho-speaking South African communities. Participants first listened to vignettes that described a person who was diagnosed with AIDS and then rated the extent to which they agreed with a variety of explanations, such as "Lerato has been bewitched by a neighbor who was jealous of her" and "Lerato used a razor with someone else's sick blood on it." Results indicated that children preferred biological

explanations to bewitchment explanations, whereas adults considered these two types of explanations as equally effective. Research in the U.S. has also found that adults are more likely than children to spontaneously provide a supernatural explanation, especially for low-probability events (Woolley, Cornelius, & Lacey, 2011). With regard to superstition specifically, survey data indicate that adults are more superstitious than children. Specifically, 46% of children between the ages of 9 and 12 report having at least one superstition compared to 63% of adults, and 45% of children say they have at least one good luck charm compared to 72% of adults (Epstein, 1993). Given these data, we might expect that appeals to superstition as a source of compensatory control will increase with age.

Belief in Nonmaterial Sources of Control: Findings with Adults

Among the other possible sources of control to which one might appeal in times of uncertainty, perhaps an omnipotent God is the most common. A recent study by Kay and colleagues (2008) demonstrated that priming adults to feel a lack of control increases belief in the existence of a controlling God. Using an autobiographical recall task, half of the participants were told to recall a time when they had absolute control and half of the participants were told to recall a time when they had absolutely no control. Next, participants rated the extent to which they believed in God. However, for half of the participants, God was described as a source of control (e.g., "To what extent do you think that God is in control of the universe?"), and for the other half of participants God was described as a creator (e.g., "To what extent do you think that God created the universe?"). Results revealed a significant interaction, such that only when God was described as a source of control did the manipulation of personal control have an effect on belief.

Other work demonstrates that it is specifically the anxiety associated with randomness that drives belief in a controlling God (Kay, Moscovitch, & Laurin, 2010). Adult participants ingested an herbal supplement, and half of the participants were told that a common side effect of the pill was mild anxiety or arousal. In reality, everyone was given a placebo pill. Participants then completed a priming task that entailed either unscrambling words that pertained to randomness or unscrambling negative words. Finally, participants were asked to rate the extent to which they agreed with various statements designed to measure their belief in a controlling God. Results revealed a significant interaction, such that participants who were primed to think of randomness and were told nothing about the side effect of the pill were most likely to believe in supernatural sources of control. There was no effect of the randomness prime for those participants who were told that the pill could cause arousal, suggesting that any anxiety participants experienced as a result of thinking about randomness was attributed to the pill's alleged side effect. These results highlight both the disquiet we experience from randomness and the tendency to appeal to God as a source of control when our personal control is threatened.

While God may be the most prototypical example of an external source of control, there is evidence that adults often appeal to other nonmaterial concepts as explanations for unpredictable events. For example, Pepitone and Saffioti (1997) presented adults with events that were designed to be difficult to explain (i.e., the outcome was unexpected and seemed to "just happen"), and asked participants for spontaneous explanations. As an example of a difficult-to-explain event, one vignette described a man who was reunited with his long-lost brother while on vacation in a remote area. Pepitone and Saffioti found that adults appeal to a host of nonmaterial concepts to explain these events, including just reward, just punishment, luck, and fate.

Belief in Nonmaterial Sources of Control: Findings with Children

Research by Woolley et al. (2011) addressed whether children also appeal to God and other nonmaterial sources of control in the service of explanation. Children between the ages of 8 and 12 years listened to vignettes describing difficult-to-explain events and provided their spontaneous explanations. These researchers found that while 8 and 10 year-olds were less likely to appeal to supernatural forces compared to adults, the 12-year-old participants did not differ from adults in their use of supernatural explanations. Analysis of the specific types of explanations revealed that while all age groups appealed to luck and karma-like explanations with equal frequency, 12-year-olds were the most likely to endorse God as a source of control. These results suggest developmental differences in the specific nonmaterial sources of compensatory control to which children might appeal.

INDIVIDUAL DIFFERENCES IN NEED FOR CONTROL

The previous sections provided evidence that people are motivated to seek compensatory control when randomness threatens their personal control. However, there is also evidence that individuals may differ in the extent to which they feel threatened by randomness, unpredictability, or lack of personal control. Furthermore, these individual differences may interact with situational factors to affect compensatory control-seeking behaviors.

For example, Keinan (1994) examined the relationships between stress, tolerance of ambiguity, and superstitious behavior. Participants included Israeli adults who either lived in cities that were prone to missile attacks during the Gulf War (a high-stress environment) or cities that were not prone to missile attacks (a low-stress environment). All participants completed an assessment of ambiguity tolerance to assess individual differences in the perception of uncertain situations as threatening. Participants also rated

how much they with agreed various forms of superstition (e.g., "It is best to step into the room right foot first" and "It's a good idea to keep a good luck charm in the house"). Results indicated a significant interaction between stress and ambiguity tolerance, such that those participants who were the least tolerant of ambiguity and also living in cities prone to missile attacks were the most likely to endorse superstitious behaviors. Keinan concluded that individuals who are low in ambiguity tolerance are especially prone to superstition in stressful contexts because such contexts often involve a high degree of unpredictability and uncertainty.

Similar effects of stress and need for control have been replicated in a lab setting. In one study (Keinan, 2002), participants were seated at a wooden table for an interview, and some of the questions asked were designed to induce a common superstitious behavior, knocking on wood (e.g., "Have you ever been involved in a fatal car accident?"). Half of the participants were asked these questions prior to taking a very important exam (high-stress condition), while the other half of participants were asked these questions on an ordinary day (low-stress condition). Participants also rated their level of agreement with statements that measured individual differences in motivation to control one's environment. Again, results revealed a significant interaction between stress and motivation to maintain control, such that among participants in the high stress environment, individuals with the strongest desire for control were the most likely to knock on wood. This illustrates how both situational and dispositional factors affect one's superstitious tendencies.

Individuals also differ in the degree to which they become anxious as a result of lacking control, and these differences affect belief in nonmaterial sources of control. Laurin et al. (2008) guided adult participants through a frightening scenario that either ended favorably due to the participant's own actions (high personal control condition) or

due to the help of somebody else (low personal control condition). For example, participants were asked to vividly imagine that a man was chasing them with a knife, and the situation either ended with participants saving themselves by making a phone call to the police (high personal control condition) or with the police suddenly intercepting the offender (low personal control condition). After this task, participants reported their subjective levels of anxiety on a 100-point scale as well as their belief in nonmaterial sources of control (e.g., "God or some other nonhuman entity"). Analyses revealed a significant interaction between the control manipulation and self-reported anxiety, such that only in the low-control condition did anxiety have an effect on belief. In other words, participants who had their personal control threatened and reported feeling anxious because of it were most likely to endorse belief in other sources of control. This study emphasizes the role of anxiety in the compensatory control process.

Although no research exists on individual differences in children's motivations to seek compensatory control, there is evidence that children differ in their tolerance of uncertainty (Comer et al., 2009). Intolerance of uncertainty is considered a dispositional trait that characterizes the tendency to react negatively on an emotional, cognitive, or behavioral level to uncertain situations and events. Comer and colleagues (2009) recently developed The Intolerance for Uncertainty Scale for Children, which consists of 27 statements that express aversion to various forms of uncertainty. Participants are asked to rate on a 5-point scale the extent to which they agree with each statement. Upon administering the scale to 197 children between the ages of 7 and 17, Comer et al. found that there were no sex differences in intolerance of uncertainty; however, intolerance of uncertainty appeared to vary with age. Specifically, these researchers reported that younger children had more difficulty tolerating uncertainty than older children. The researchers speculated that perhaps normative development consists of an increased

ability to tolerate uncertain events. This finding leads to interesting predictions about how children of different ages cope with uncertainty and lack of control. On the one hand, younger children may be more motivated than older children to seek sources of control given their greater discomfort with uncertainty. However, it could also be the case that older children are better able to tolerate uncertain situations because they have already learned alternative means of maintaining a sense of control.

SUMMARY AND STUDY OVERVIEW

The world in which we live is undoubtedly chaotic, yet people tend to shy away from this harsh reality and instead maintain the belief that the world is orderly and predictable. One way that this worldview is maintained is via personal control, or one's belief in his or her ability to personally affect or predict events. However, when random or otherwise unpredictable events threaten personal control, adults will turn to alternative sources of control in order to maintain the belief that events do not happen arbitrarily.

It is unclear whether children also perceive a lack of control as threatening. It seems that in order to feel threatened by randomness, one must first be able to identify it. Given younger children's less sophisticated understanding of what constitutes a random event, they may be less inclined to seek compensatory control when faced with a seemingly random event simply because they do not sense a threat to their personal control. Even if younger children are able to detect randomness and experience it as threatening, it is likely that the availability of particular sources of compensatory control develops as children become increasingly socialized to the specific customs and beliefs of their society. If this is the case, we might expect children of all ages to seek comfort in the most basic form of compensatory control, pattern detection, but endorsing specific

superstitious behaviors and expressing explicit belief in nonmaterial sources of control might not occur until later in development.

The current studies investigated the process of compensatory control in children. The first study had 2 objectives: 1) to test the efficacy of a novel personal control manipulation, and 2) measure the effects of age, lack of control, and intolerance of uncertainty on the most basic of the compensatory control processes, namely visual detection of patterns in random noise. The objective of the second study was to use the novel personal control manipulation to further investigate the effects of age, lack of control, and intolerance of uncertainty on the motivation to seek other sources of compensatory control, including the endorsement of superstitious behavior and belief in supernatural sources of control.

Method of Study 1

PARTICIPANTS

Participants for Study 1 were 53 children (28 female), ranging in age from 6 to 12 years. One participant was excluded from analysis after his parents notified the experimenter that he had been diagnosed with Autism Spectrum Disorder. Of the 52 participants included for analysis, there were 3 6-year-olds (M = 82.10 months), 11 7-year-olds (M = 91.64 months), 10 8-year-olds (M = 104.26 months), 8 9-year-olds (M = 117.55 months), 8 10-year-olds (M = 126.65 months), 10 11-year-olds (M = 141.42 months), and 2 12-year-olds (M = 152.25 months). Sixty-seven percent of the participants were Caucasian, 11.5% were Hispanic or Latino, 8% were Asian, and 13.5% were more than one race. The majority of participants (85%) were recruited from the Children's Research Laboratory database, and some participants (15%) were recruited from a local recreational center.

MATERIALS

Intolerance of Uncertainty Scale

The purpose of this scale was to measure individual differences in children's willingness to tolerate uncertainty. The scale consisted of 10 items that were developed by modifying items from the Intolerance of Uncertainty Scale for Children (Comer et al., 2009). The original items were modified to 1) decrease the total amount of time required to administer the scale, and 2) reduce the complexity of the vocabulary and sentence structure of the items. For example, Comer et al.'s items, "Plans can be ruined by things you didn't think would happen" and "One should always think ahead to avoid surprises" were modified in the current study with the item, "I always think ahead so that I don't

get surprised" (see Appendix A). The 10 items used for this study always appeared in the same order. Participants were asked to rate the extent to which they agreed with each item using a 5-point scale, ranging from "not at all" (0) to "all the way" (4). Two of the 10 items expressed a tolerance of uncertainty and were reverse-scored. A laminated version of the 5-point scale was available for participants to indicate their responses.

Plinko Computer Game

The purpose of this game was to prime children to feel either high personal control or low personal control as a result of perceived randomness. The game consisted of a pegboard with five slots at the top and five bins at the bottom. The objective of the game was to correctly predict which of the bins a ball would land in after it was dropped from one of the slots at the top of the pegboard (see Appendix B for screenshots). Participants used the mouse to indicate their predicted bin, and then they chose a slot at the top from which to drop the ball. The game was created to result in one of two possible scenarios: 1) the participant guessed the correct bin on 8 of the 10 trials (high-control condition), or 2) the participant guessed the incorrect bin 8 of the 10 trials (low-control condition). In the high-control condition, participants were incorrect on trials 4 and 7; the low-control condition, participants were correct on trials 4 and 7.

Object Detection Task

This task was a modified version of a task used by Whitson and Galinsky (2008), which entailed presenting participants with images of white noise (i.e., randomly distributed black and white pixels) and asking them to report whether they see an object in the image. In studies with adults (Whitson & Galinsky, 2008), participants viewed the stimuli on paper and wrote their responses on a response form. In order to increase engagement for children and to reduce the demands required to print words, the stimuli

used for the current study were pasted into a PowerPoint presentation, and each image was displayed on the computer screen for 2 seconds. Participants verbally reported what object, if any, they detected in the images. Two of the images (image 3 and image 7) had a shape embedded in the noise (see Appendix C). The order of presentation was the same for all participants.

PROCEDURE

Participants were seen on an individual basis. Upon obtainment of informed consent and assent, participants sat at a table, and the researcher outlined the tasks of the experiment. The researcher explained that first she was going to read some sentences and ask the children how much they agreed with each sentence using the 5-point scale. The experimenter pointed to each of the 5 response options on the laminated scale, and children were told they could either state their response or point to it on the scale. Children then practiced using the scale for 3 items. Each practice item expressed an opinion (e.g., "I think that vegetables taste better than fruit"), and participants indicated how much they agreed with each item (see Appendix D for script). No feedback was given for children's responses to these practice items. Before moving on to the intolerance of uncertainty items, the experimenter emphasized that there were no right or wrong answers, and participants were encouraged to answer in a manner that best reflected their thoughts. Then the experimenter read each of the 10 items from the intolerance of uncertainty scale, and participants indicated their level of agreement with each statement.

Next, the experimenter directed children's attention to the computer screen and introduced the Plinko game by saying, "See this pegboard? In a minute, you're going to drop a ball from one of these slots at the top of the board. But first, I want you to make a

guess about where you think the ball will land. To make your guess, you'll click on one of these blue arrows at the bottom (*experimenter points to bins at the bottom of the pegboard*). Then, after you make your guess, you'll click on one of these purple arrows at the top to drop the ball (*experimenter points to slots at the top of the pegboard*). We'll watch the ball go down the pegboard and see if it lands in the bin that you guessed. The goal of this game is to get as many guesses right as you can, and you'll get 10 tries. Does that make sense? Are you ready?" Children then took control of the mouse and completed all 10 trials of the version of the game to which they had been randomly assigned (i.e., high control or low control).

After playing Plinko, participants were asked a series of questions designed to measure whether the game successfully manipulated their perceived control. First, participants answered an open-ended question about their thoughts on the game ("So, that's the end of the game; what did you think about it?"). Second, children were asked to indicate how much they believed they were in control of what happened in the game on a 5-point scale ranging from "not at all" to "all the way" ("Tell me, how much do you think you were in control of what happened in that game?"). Third, children predicted how many guesses they would get right if they were to play the game again, using a 5-point scale ranging from "none of the times" to "all of the times" ("If we were to play that game again, how many times do you think you would get your guesses right?"). Fourth, children indicated their negative affect on a 5-point scale ranging from "not at all" to "all the way" ("How upset or bothered are you?"). Finally, the experimenter invited children to share any other thoughts they had about the game before proceeding to the final task of the experiment ("Do you have anything else you would like to tell me about the game before we move on to something else?").

The researcher then introduced the object detection task by saying, “Now we are going to do a test to see how good you are at seeing things quickly. I’m going to show you some pictures, and I want you to tell me as fast as you can what things you see. Here is an example of what the pictures will look like.” An example image of white noise was displayed on the screen for 2 seconds and then disappeared. The experimenter proceeded by saying, “Now, some of the pictures might not have something in them. So, if you don’t see anything, that’s okay. You can just tell me that you see nothing. But if you do see something, tell me the name of the thing that you see. Your job is to get as many of these right as you can. Are you ready?” The experimenter then presented the 10 images, one at a time, for 2 seconds each, and recorded what objects, if any, the children named. Upon completion of this task, participants were debriefed and given a small toy for their participation.

SCORING

Intolerance of Uncertainty Scale

Children’s responses to the 10 items were summed to create a single intolerance of uncertainty score (the two statements that reflected a tolerance of uncertainty were reverse-scored). Possible total scores ranged from 0 to 40, with lower scores reflecting more tolerance of uncertainty and higher scores reflecting more intolerance of uncertainty.

Object Detection Task

The dependent measure was the total number of objects that participants named in the object detection task.

Results of Study 1

Intolerance of Uncertainty Scale

Chronbach's alpha for the 10 items was .40, which indicated poor interrelatedness between the items (see Table 1 for intercorrelations among items). Deleting items from the scale did not result in improved reliability. Thus, this measure was not used in subsequent analyses for Study 1.

Manipulation Check

To assess whether children's perceived control, predictability, and affect depended on the version of Plinko that they played, independent-samples *t*-tests were conducted on responses to the post-Plinko questions. Results indicated that children in the high-control condition (M = 2.65, SD = .98) perceived themselves as having significantly more control over the game than children in the low-control condition, (M = 1.31, SD = 1.10), $t(50)$, = 4.79, $p < .001$. When asked to predict their potential success on the next round of the game, children in the high-control condition (M = 2.88, SD = .65) predicted significantly more success than children in the low-control condition (M = 1.54, SD = .65), $t(50) = 7.47$, $p < .001$. The difference in negative affect between the conditions was not significant, $t(50) = 1.11$, $p > .20$. Children rarely reported being upset after playing the game, regardless of whether they were in the low-control condition (M = .54, SD = .91) or the high-control condition (M = .31, SD = .55). Age was significantly negatively correlated with children's predicted success, r = -.33, $p < .05$, indicating that younger children were more likely to predict success on a hypothetical next round of the game compared to older children.

OBJECT DETECTION TASK

Due to the low reliability of the intolerance of uncertainty scale, children's total intolerance of uncertainty score was not used as predictor of performance on the object detection task. Correlations between each of the items on the intolerance of uncertainty scale and the total number of objects detected indicated a significant positive relationship for only item 4 of the intolerance of uncertainty scale ("I like going to new places where I don't know what's going to happen."), $r = 28$, $p < .05$.

Multiple regression analysis was used to examine whether children's tendencies to detect objects varied by age, gender, and condition (age was entered as a continuous variable, while gender and condition were dummy coded). Results indicated that responses did not vary as a function of age, gender, or condition, $F(3, 48) = .905$, $p > .20$. On average, children in the low-control condition detected 5.65 objects ($SD = 2.40$), and children in the high-control condition detected an average of 4.73 objects ($SD = 2.84$). Females detected an average of 5.21 objects ($SD = 2.80$), and males detected an average of 5.17 objects ($SD = 2.51$). Age was also converted to a categorical variable with 6- and 7-year-olds in one group ($n = 14$), 8- and 9-year-olds in a second group ($n = 18$), and 10-, 11-, and 12-year-olds in a third group ($n = 20$). A one-way ANOVA did not reveal any age differences in performance on the object detection task, $F(2, 49) = 1.15$, $p > .20$. Figure 1 depicts the number of objects detected as a function of participant age (treated as a continuous variable).

Discussion of Study 1

Study 1 had two primary goals: 1) to test the efficacy of a new personal control manipulation for children, and 2) to observe its effects on the detection of patterns. As measured by the questions following the game, Plinko did successfully manipulate participants' sense of control and predictability, at least within the context of the game. Interestingly, the high-control and low-control conditions did not differ in negative affect. According to theory of compensatory control (Kay et al. 2009), it is the negative affect, specifically anxiety, that results from a lack of personal control that motivates adults to seek compensatory sources of control. To the extent that our negative affect question captured anxiety, this may be why condition had no effect on children's inclination to detect patterns in random noise. That is, although children recognized a lack of control, they were not made anxious by it, and thus felt no need to compensate. Another possibility is that children's perceptions of lack of control in the game did not affect their sense of personal control about events more generally; this issue is further discussed in the general discussion.

It was predicted that children's intolerance of uncertainty would also be associated with their inclination to detect patterns in random noise. However, due to the lack of reliability of the intolerance of uncertainty scale, this relationship could not be adequately assessed. There are a couple of potential explanations for why children's patterns of responses were inconsistent across the items on the scale. One possible explanation for the low reliability of the scale was that not all children completed the study in the same environment. Fifteen percent of participants were tested at a recreational center in the presence of many distractions (most notably all the other children playing), whereas other participants completed the study in a quiet room with

only the experimenter present. To eliminate this potential confound, all participants in Study 2 completed the experiment at the Children's Research Lab.

Another possible explanation for the poor reliability of the scale is the age of the participants. The original Intolerance of Uncertainty Scale for Children (Comer et al., 2009), was found to be reliable for children between the ages of 7 and 17, but the current study did include some 6-year olds. Comer et al. (2009) also found that younger children reported less tolerance of uncertainty, however, the researchers cautioned that this age difference might have been the result of younger children interpreting the items differently than older children. In the current study, over half of the sample was 8 years old or younger compared to only 20% of the sample used by Comer et al. If it is the case that younger children interpreted the items differently than older children, this may have resulted in inconsistent patterns of responding for a substantial percentage of the current sample, thus affecting the overall measure of reliability.

Age was also negatively correlated with the amount of success that children predicted they would have if they were to play Plinko again. This correlation was mainly due to the performance of the 6- and 7-year-olds; when examining only the children who were older than 8 years, the relation between age and predicted success was no longer significant. Other research has also found that children younger than 8 years predict more success on games of chance than do older children (Weisz, 1980). Given this age-related finding and the possibility that the youngest children in the sample were answering inconsistently on the intolerance of uncertainty scale, Study 2 aimed to recruit more participants from the upper-end of the age distribution, and 6-year-olds were not included.

Previous research has suggested that pattern perception may be the most basic instantiation of compensatory control, at least in adults (Kay et al., 2009). However,

children's perceived lack of control did not predict the extent to which they detected patterns in random noise. As mentioned previously, one possibility is that children did not feel threatened by their lack of control and thus did not feel the need to compensate. However, children's responses did vary greatly on this task, with some children detecting an object in every image, and other children only reporting objects for the two images in which a shape was actually embedded. It is possible that children interpreted the instructions of the task differently (both from other children and from adults), with some realizing that incorrect responses were possible, and others viewing the task more subjectively. To further examine the effects of lack of control on children's compensatory control-seeking behavior, Study 2 included multiple dependent measures.

Method of Study 2

PARTICIPANTS

Fifty-four children between the ages of 7 and 12 years participated in Study 2; however, two children were excluded due to inattentiveness. Of the 52 participants included for analysis, there were 7 7-year-olds (M = 91.63 months), 7 8-year-olds (M = 103.88 months), 14 9-year-olds (M = 115.17 months), 12 10-year-olds (M = 127.40 months), 3 11-year-olds (M = 140.6 months), and 9 12-year-olds (M = 151.32 months). Thirty-five participants were male, and 17 participants were female. Sixty-one percent of the participants were Caucasian, 17% were Hispanic or Latino, 15% were Asian, and 6% were more than one race. All participants were recruited from the Children's Research Laboratory.

MATERIALS

Intolerance of Uncertainty Scale

The same scale from Study 1 was used in Study 2 to measure individual differences in intolerance of uncertainty (see Appendix A).

Plinko Computer Game

The same game from Study 1 was used in Study 2 to create a high-control condition and a low-control condition.

Story Task

This task included six vignettes. Each vignette described a character who performed some action (e.g., spinning around in a circle), and each vignette ended with a focal event (e.g., winning a lottery contest). All of the vignettes were read aloud and were accompanied by a photograph of a child obtained from Google images. After listening to

each vignette, participants rated how much they thought the event was caused by the actor's action, using a 5-point scale ranging from "not at all" to "all the way" (e.g., "How much do you think that happened because she spun around in a circle?"). Of the six vignettes, two included the performance (or lack of performance) of superstitious or ritualistic behaviors (one positive outcome and one negative outcome), two vignettes involved to the use (or lack of use) of a lucky object (one positive outcome and one negative outcome) and two pertained to karma-like beliefs (one positive outcome and one negative outcome). The order of presentation was randomized for each participant (see Appendix E for all vignettes).

Explicit Belief Task

Participants were asked to rate their level of agreement with three statements that assessed belief in supernatural sources of control -- God, lucky charms, and karma -- using a 5-point scale ranging from "not at all" to "all the way." The statements were as follows: "Things happen in the world because God makes them happen," "Lucky charms make good things happen," and "Good things happen to good people and bad things happen to bad people" (see Appendix F). The order of the statements was counterbalanced.

PROCEDURE

As in Study 1, participants were seen on an individual basis. Upon obtainment of informed consent and assent, participants sat at a table, and the researcher outlined the tasks of the experiment. Children were shown the 5-point scale and instructed on how to use the scale to indicate their responses. The first part of Study 2 was identical to Study 1. Participants first answered the practice items and then rated their agreement with the items from the intolerance of uncertainty scale. Next, children played the version of

Plinko to which they had been randomly assigned (high or low control), and then they answered the manipulation check questions.

The order of the dependent measures was counterbalanced, such that half of the participants first completed the story task followed by the explicit belief task, while the other half of participants first completed the explicit belief task followed by the story task. The experimenter introduced the story task by saying, "Okay, now I am going to tell you about six kids and some things that happened to them. After I tell you about each one, I am going to ask you a question about what *you* think happened." Then the experimenter read the six vignettes, one at a time, and participants rated, using the 5-point scale, how much they thought the event was caused by the action of the character. When introducing the explicit belief task, the experimenter said, "Okay now I'm going to read you some more sentences, and I want you to tell me how much you agree with them." After the participants heard each statement, they used the 5-point scale to indicate their level of agreement. Once children completed both the story task and the explicit belief task, they were debriefed and given a small toy for their participation.

SCORING

Intolerance of Uncertainty Scale

Children's responses to the 10 items were summed to create a single intolerance of uncertainty score (the two statements that reflected a tolerance of uncertainty were reverse-scored). Possible total scores ranged from 0 to 40, with lower scores reflecting more tolerance of uncertainty and higher scores reflecting more intolerance of uncertainty.

Story Task

For each of the six vignettes, children rated how much they thought the event was caused by the character's action, using a 5-point scale. For each type of vignette (superstition, luck, karma), the responses for the two vignettes (positive outcome and negative outcome) were summed. Responses to all of the vignettes were summed to assess the overall extent to which participants perceived a causal relationship between the events and the characters' actions. For each story type, scores ranged from 0 to 8, and overall scores ranged from 0 to 24, with lower scores indicating weaker causal relationships and higher scores indicating stronger causal relationships.

Explicit Belief Task

Participants were asked to rate their level of agreement with each of the three statements of explicit belief (God, luck, karma) using a 5-pont scale ranging from "not at all" to "all the way." Responses to these questions were summed to assess overall belief in supernatural sources of control. Possible scores ranged from 0 to 12, with lower scores indicating less belief and higher scores indicating more belief.

Results of Study 2

Intolerance of Uncertainty Scale

The Chronbach's alpha for the 10 items was .68, which indicated satisfactory internal consistency of the scale (see Table 2 for intercorrelations among items). While there was no overall relationship between participants' age and intolerance of uncertainty, age was significantly correlated with a few of the items on the scale. Specifically, age was positively correlated with item 7 ("I always think ahead so that I don't get surprised"), $r = .32$, $p < .05$; age was negatively correlated with item 8 ("I wish we could always know what's going to happen in the future"), $r = -.33$, $p < .05$, and age was positively correlated with item 9 ("Other kids are usually more sure about things than I am"), $r = .33$, $p < .05$. Figure 2 displays scores on the intolerance of uncertainty scale as a function of participant age. Age was also converted to a categorical variable to explore potential age differences. The youngest group consisted of 7- and 8-year-olds ($n = 14$), the middle-aged group consisted of 9- and 10-year-olds ($n = 26$), and the oldest group consisted of 11- and 12-year-olds ($n = 12$). A one-way ANOVA indicated no significant effect of age group on intolerance of uncertainty score, $F(2, 49) = 1.61$, $p > .20$.

An independent-samples *t*-test revealed a marginally significant difference between males ($M = 20.26$, $SD = 6.84$) and females ($M = 16.65$, $SD = 5.38$) in their intolerance of uncertainty, $t(50) = 1.90$, $p = .06$. Intolerance of uncertainty scores did not differ by condition ($t(50) = .80$, n.s.); the average score for participants in the low-control condition was 18.32 ($SD = 6.89$), while the average score for participants in the high-control condition was 19.78 ($SD = 6.33$).

MANIPULATION CHECK

Similar to the results of Study 1, children in the high-control condition (M = 2.52, SD = .94) perceived themselves as having significantly more control over the game than children in the low-control condition, (M = 1.20, SD = .71), t(50), = 5.70, $p < .001$. When asked to predict their potential success on the next round of the game, children in the high-control condition (M = 2.78, SD = .43) predicted significantly more success than children in the low-control condition (M = 1.48, SD = .59), t(50) = 9.01, $p < .001$. The difference in negative affect between the conditions was marginally significant, t(50) = 1.88, p = .07. Children in the low-control condition (M = .44, SD = .71) reported being slightly more upset than children in the high-control condition (M = .15, SD = .36), although the means for both conditions were quite low. Age was not significantly correlated with any of the manipulation check questions (i.e., perceived control, predicted success, or negative affect).

STORY TASK

Multiple regression analysis was used to examine whether participants' responses to the vignettes varied by age, gender, intolerance of uncertainty, condition (high control or low control), and the order of the two dependent measures (story task first or explicit belief task first). In the first model, the aforementioned variables were entered as predictors of the sum of the participants' responses for all six vignettes (age and intolerance of uncertainty were entered as continuous variables, while gender, condition, and order were dummy coded). Results indicated no significant predictors, thus separate analyses were conducted for each story type separately (i.e., superstition, karma, and luck). For both the superstitious stories and the luck stories, there were no significant predictors; however, children overall endorsed the explanations for the luck stories (M = 2.27, SD = 1.92) significantly more than they did the explanations for the superstitious

stories (M = 1.25, SD = 1.69), $t(51) = 4.09$, $p < .001$ (see Figure 3 for endorsement as a function of story type and condition).

For the karma stories, results indicated that both age (β = -.35, $p < .01$) and condition (β = -.30, $p < .05$) were significant predictors. A forward-selection stepwise regression resulted in a model with only age as a significant predictor (β = -.37, $p < .01$), $R^2 = .14$, $F(1,50) = 7.89$, $p < .01$; condition was excluded due to marginal significance (β = -.25, $p = .06$). With both age and condition entered into a model, the two variables accounted for 18% of the variance in children's responses to the karma stories, $F(2, 49) = 5.99$, $p < .01$. Comparison of the AICs for the one-predictor and two-predictor models revealed a slightly lower AIC for the model with both age and condition compared to the model with only age (4.62 and 4.78, respectively).

A 2 (condition: high control, low control) x 3 (age group: youngest, middle, oldest) ANOVA confirmed a significant main effect of condition, $F(1,46) = 4.16$, $p < .05$, and a significant main effect of age group , $F(2, 46) = 4.73$, $p < .01$, on endorsement of explanations in the karma stories (see Figure 4). With regard to condition, children in the low-control condition (M = 3.16, SD = 3.53) endorsed the karma explanations significantly more than did children in the high-control condition (M = 1.89, SD = 1.99), $t(50) = 2.02$, $p < .05$. With regard to age, post hoc tests using Bonferroni correction indicated that the youngest group (M = 3.93, SD = 3.01) endorsed karma explanations marginally more than the middle-aged group (M = 2.19, SD = 1.94), $p = .06$, and significantly more than the oldest group (M = 1.50, SD = 1.24), $p < .01$. Endorsement of karma explanations did not differ significantly between the middle-aged-group and the oldest group, $p > .20$. Treating age as a categorical variable did not reveal any significant effects of age on the endorsement of the luck stories, the superstition stories, or the endorsement of all story types combined (all ps > .20).

EXPLICIT BELIEF TASK

Multiple regression analysis was used to examine whether participants' responses to the explicit belief questions varied by age, gender, intolerance of uncertainty, condition (high control or low control), and order of the dependent measures (story task first or explicit belief task first). In the first model, the aforementioned variables were entered as predictors of the sum of the participants' responses for the 3 explicit belief questions (age and intolerance of uncertainty were entered as continuous variables; gender, condition, and order were dummy coded). Results indicated that the order in which participants received the dependent measures affected their responses to the explicit belief questions as a whole, $F(5, 46), = 2.32$, $p < .10$, $R^2 = .20$. When all variables were entered in the model, the order of the dependent measures was the only significant predictor ($\beta = -.37$, $p = .01$). Post-hoc analyses revealed that the effect of order was present only for the explicit belief question pertaining to luck. Specifically, children who received the luck story task first were significantly more likely to report belief in the efficacy of lucky charms compared to children who first answered the explicit belief question about lucky charms, $t(49) = 2.56$, $p = .01$. No other variables emerged as significant predictors of children's responses to the explicit-belief questions about either luck or karma. Treating age as a categorical variable did not reveal any age differences in children's responses to the three explicit belief questions ($ps > .20$).

For the explicit-belief question about God's causal role in the world, intolerance of uncertainty emerged as the sole significant predictor ($\beta = .31$, $p < .05$). A forward-selection stepwise regression resulted in a model with only intolerance of uncertainty as a significant predictor ($\beta = .32$, $p < .05$), $R^2 = .11$, $F(1,50) = 5.88$, $p < .05$. Intolerance of uncertainty was significantly correlated with responses to the explicit-belief question about God, $r = .34$, $p < .05$ (see Figure 5).

Discussion of Study 2

One goal of Study 2 was to re-examine the reliability of a new measure of children's intolerance of uncertainty. Compared to Study 1, children's responses to the items on the intolerance of uncertainty scale in Study 2 were more intercorrelated, allowing this scale to serve as a reliable measure of individual differences in children's willingness to tolerate uncertainty. One possible explanation for the difference in reliability between the studies is the distribution of ages. Although the samples from Study 1 and Study 2 had comparable mean ages (9.38 and 9.94, respectively), nearly 50% of participants in Study 1 were 8 years old or younger compared to only 27% of participants in Study 2. As mentioned in the previous discussion, the youngest children in Study 1 may have had trouble interpreting some of the items, (e.g., those that were reverse scored), which resulted in inconsistent patterns of responding across the items. Combining the participants from the two studies and computing Chronbach's alpha for each age group (6-, 7- and 8-year-olds, 9- and 10-year-olds, and 11- and 12-year-olds) supports this explanation. Specifically, these analyses indicate an increase in alpha between each of the age groups (.49, .60, .63, respectively). Because Comer et al. (2009) cautioned that their obtained age differences in intolerance of uncertainty scores may have be the result of age differences in interpretation of the items, the current studies modified items from those developed by Comer et al. with the aim of reducing difficulty in interpretation (e.g., "Not knowing what will happen in the future makes me uneasy, anxious, or stressed" was changed to "I worry a lot about what's going to happen in the future"). However, the youngest children in Study 1 may still have misinterpreted some of the items, thus, including less of them in Study 2 may have improved the reliability of the scale.

It could also be the case that increased consistency in response patterns with age reflects something about the development of a general intolerance of uncertainty, with older children exhibiting this trait in a variety of contexts and younger children's intolerance of uncertainty being more context-specific. Future research should investigate when in development this trait emerges and the extent to which it is related to other dispositional traits, such as infant temperament or adult personality. The current study did not find any age differences in overall intolerance of uncertainty scores; however, more research is needed to determine whether this is a stable individual difference. The current study also found a marginal gender difference in intolerance of uncertainty, with males reporting less tolerance than females. It is difficult to interpret the implications of this finding, given that males were overrepresented in the sample, and gender differences in intolerance of uncertainty have not been found in previous studies with children (Comer et al., 2009) or adults (Holaway, Heimberg, & Coles, 2006).

One hypothesis of Study 2 was that individual differences in intolerance of uncertainty would predict children's compensatory control-seeking behavior as measured by 1) their endorsement of supernatural explanations, and 2) their agreement with explicit belief in supernatural sources of control. While there was no effect of intolerance of uncertainty on endorsement of explanations in the story task, there was a significant relationship between children's intolerance of uncertainty scores and their explicit belief in God as a casual agent. Previous research with adults has found a similar relationship between uncertainty tolerance and belief in God (e.g., Valdesolo and Graham, 2013); however, this is the first study to date that documents this relationship in children. Potential implications of this finding are saved for the general discussion.

A second prediction for Study 2 was that children who were primed to experience a lack of control would be more inclined to seek compensatory control with the

endorsement of supernatural explanations and explicit beliefs. Results indicated that Plinko did successfully manipulate children's perceived control and predictability, and that this manipulation had a significant effect on children's endorsement of karma-like explanations for positive and negative events. It is worth noting that the difference in negative affect between the high-control and low-control conditions was marginally significant. This lends support to the notion that anxiety due to lack of control is the mechanism by which we are motivated to find sources of compensatory control in order to regain a sense of order and predictability (Kay et al., 2009).

However, lack of control and subsequent negative affect did not increase children's willingness to endorse explanations pertaining to ritualistic behaviors or the efficacy of lucky charms. One possible explanation for the differences across story types is that both ritualistic behaviors, such as knocking three times before entering the library, and the use of lucky charms, such as a special pair of socks, are often person-specific. In contrast, a belief in karma, or the idea that what goes around comes around, is applicable to everyone. However, it is unclear why priming adults with a lack of control leads to increased endorsement of explanations pertaining to other people's superstitious behaviors (Whitson & Galinsky, 2008). Perhaps children have less personal experience with the use of routine rituals compared to teenagers and adults, and as they hear more testimony about the efficacy of these behaviors, they become increasingly willing to perform them when their personal control is threatened.

Although condition did not affect responses to the superstitious and luck stories, children of all ages were more likely to endorse the explanations in the luck stories than those in the superstitious stories. Interestingly, many children who agreed that the events in the luck stories were caused by the presence or absence of the lucky charm explained their agreement with natural processes. That is, very few children actually thought that

there were "magical powers or something" in the charms; rather, most children maintained that these objects led to positive outcomes via the "confidence," "motivation," "focus," and "effort" that they instilled in their owners. Similarly, children explained that the negative outcomes were due to the owner's rumination about the absence of the lucky charm, and that these thoughts led to "no confidence," "worrying too much," and "not enough brain power." It is not all that surprising that children this age are skeptical of magical causation (Phelps & Woolley, 1994; Rosengren & Hickling, 2000); nonetheless, their ability to explain the cognitive consequences of other people's belief in lucky charms was striking. Other research has similarly found that children prefer natural over supernatural explanations (e.g., Legare & Gelman, 2008; Woolley et al., 2011).

It is also interesting that the order in which children received the dependent measures affected their responses to the explicit belief question about lucky charms. Children who first heard the explicit belief question about lucky charms were less likely to agree with this question compared to children who first heard the stories about a lucky charm causing a positive event (and the absence of a lucky charm causing a negative event). That is, children who had already explained that confidence is the mechanism by which lucky charms work were more likely to agree with the statement, "lucky charms make good things happen."

The only instance in which age had an effect was on the endorsement of the karma stories, with younger children more likely to agree with karma-like explanations than older children. This developmental trajectory was first established by Piaget (1932/1965), who described young children as adhering to the belief "that a fault should automatically bring about its own punishment" (p. 256). Subsequent research has replicated the decline with age in the use of explanations pertaining to immanent justice

(Jose, 1991; Suls & Kalle, 1979). Yet, there is evidence that children as old as 12 will spontaneously appeal to the valence of a character's action when explaining positive and negative outcomes (Woolley et al., 2011), and even adults have been shown to justify a positive or negative event with a person's deservingness of that event in order to maintain a belief that the world is fair, orderly, and predictable (Callan, Ellard, & Nicol, 2006; Lerner, 1978; Pepitone & Saffioti, 1997, Raman & Winer, 2004).

General Discussion

A sense of personal control, whether perceived or actual, affords us predictability, making us effective agents in a world that is often characterized by uncertainty. Research indicates that when adults perceive a threat to their personal control, and experience that threat as psychologically aversive, they compensate by seeking other sources of control in order to reduce uncertainty and restore order and predictability (Kay et al., 2009). The purpose of this dissertation was to explore whether children feel threatened by lack of control and uncertainty and whether they seek similar sources of compensatory control as adults.

In the current studies, manipulating children's ability to make accurate predictions affected the extent to which children believed they were in control of the situation. However, it is not the lack of control per se that motivates one to seek compensatory control, rather one must experience that lack of control as psychologically aversive, and thus become motivated to avoid that negative affect by regaining control via some source other than the self. In Study 1, there were significant differences between children in the low-control condition and those in the high-control condition with regard to perceived control and predictability; however, the conditions did not differ in negative affect, nor did they differ in their inclination to perceive patterns in random noise. In Study 2, the conditions not only differed in perceived control and predictability, but children in the low-control condition reported more negative affect than those in the high-control condition, and they were more likely to endorse karma-like explanations than children in the high-control condition.

Admittedly, the degree to which children in the low-control condition reported negative affect was low; the average score for children in this condition was .44, with "0"

corresponding to "not at all" and "1" corresponding to "a little bit." One limitation to using a computer game as a control manipulation is that most children have experienced lack of control within the context of games and have learned (either from experience or from direct instruction) that such contexts are not worth getting upset about. For example, many children explained that they were not upset because "it was just a game" and that one "shouldn't get upset at losing games." Although some work with adults has used computer tasks to prime lack of control (e.g., Whitson & Galinsky, 2008) most studies have used either autobiographical recall tasks, in which participants are asked to write a detailed account of a time when they experienced either high or low control (e.g., Rutjens, van Harreveld, & van der Pligt, 2010; Wang, Whitson, & Menon, 2012), or guided imagery tasks, in which participants are asked to imagine frightening situations in the context of either high control or low control (e.g., Laurin et al., 2008; Shepherd, Kay, Landau, & Keefer, 2011). This type of manipulation links the lack of control to one's personal history and may be perceived as more threatening to one's overall personal control compared to manipulations that take place on a computer and are not specific to the individual. Future research could adapt these other methods of control manipulation to determine whether children report more anxiety at the thought of personal experiences involving lack of control and are thus more inclined to seek compensatory control than they were in the current study.

An alternative explanation is that, although children recognize a lack of personal control, this recognition does not result in increased anxiety or motivation to seek compensatory control in the same way that it does for adults. For children, other people such as parents and teachers are often in control. If children experience a lack of personal control in one situation, they may not feel threatened because they still believe that someone, somewhere is control of most events. It may not be until adolescence, when

individuals are given more independence, that they develop a global sense of personal control that can truly be threatened by unpredictable events. More research is needed to test these possible explanations.

Participants' responses on the intolerance of uncertainty scale suggest that there is a great deal of variation in how much children are willing to tolerate uncertainty. Similar variation has been found on the adult version of the Intolerance of Uncertainty Scale (Freeston, Rheaume, Letarte, Dugas, & Ladouceur, 1994). Given that this is one of the first studies to measure these individual differences in children, there is much work to be done regarding both the development of this trait and its implications. Research with adults has focused primarily on how individuals who are less tolerant of uncertainty are negatively affected, such as with increased worry (Dugas, Gosseline, & Ladouceur, 2001), depression (Miranda, Fontes, & Marroquín, 2008), social anxiety (Carleton, Collimore, & Asmundson, 2010) or high blood pressure (Greco & Roger, 2003). Since the development of the first intolerance of uncertainty scale for children in 2009 by Comer et al., research with youth has focused solely on clinical application (e.g., Kertz & Woodruff-Borden, 2013; McEvoy & Mahoney, 2011; Thibodeau et al., 2015), but it is important to assess whether this trait is related to non-clinical developmental outcomes as well. For example, educators and psychologists should explore the pedagogical implications for children's intolerance of uncertainty, such as whether it is related to decreased confidence in problem-solving, lower self-esteem, or learned helplessness.

The current study found that one consequence of an intolerance of uncertainty is an increased belief in God as a causal agent. This is a noteworthy finding, because the role of individual differences in children's religious cognition has been entirely neglected thus far. Existing research focuses on demographic factors, such as family religiosity (Wenger, 2001) and religious education (Vaden & Woolley, 2011), or cognitive

developmental factors, such as the ability to use testimony (Harris, Pasquini, Duke, Asscher, & Pons, 2006) and the development of a theory of mind (Barrett, 2004; Bering & Parker, 2006). Of course, this correaltional finding does not permit us to infer that intolerance of uncertainty causes one to believe in God; it could be that those who believe in God become less tolerant of uncertainty, especially if their god is considered to be all-knowing and all-powerful. Nonetheless, it is informative to consider individual differences alongside demographic and developmental factors when attempting to answer the interesting question of why some children are more receptive to the idea of God than others.

Finally, although the current study focused on children's use of supernatural sources of control, compensatory control need not be supernatural. Research indicates that adults will also appeal to controlling institutions, like the government, and secular beliefs, like belief in progress, to preserve a sense of order. For example, data collected from participants in 67 countries demonstrates a negative correlation between perceived personal control and preference for governmental control (Kay et al., 2008), and experimental evidence indicates that adults who are primed with a lack of control are more likely to agree with statements such as, "In two decades, we will live in a better world than that of today" (Rutjens et al., 2010). Whether there are similar secular sources of control that children may find attractive has yet to be determined. Furthermore, it is unclear why, given the same motivation to maintain the belief that the world is not random, some people are motivated to find comfort in supernatural sources of control while others seek control from natural sources. Hopefully more scientific inquiry can address these unanswered questions.

Appendix A: Modified Intolerance of Uncertainty Scale

1. It really bothers me when I'm not sure about things. How much do you agree that it really bothers you when you're not sure about things?

   0 1 2 3 4

2. I worry a lot about what's going to happen in the future. How much do you agree that you worry a lot about what's going to happen in the future?

   0 1 2 3 4

3. Sometimes I can't make up my mind, and that frustrates me.

   0 1 2 3 4

4. I like going to new places where I don't know what's going to happen. [RS]

   0 1 2 3 4

5. I always like to know my plans for the next day.

   0 1 2 3 4

6. It's okay if I am not sure about things. [RS]

   0 1 2 3 4

7. I always think ahead so that I don't get surprised.

   0 1 2 3 4

8. I wish we could always know what's going to happen in the future.

   0 1 2 3 4

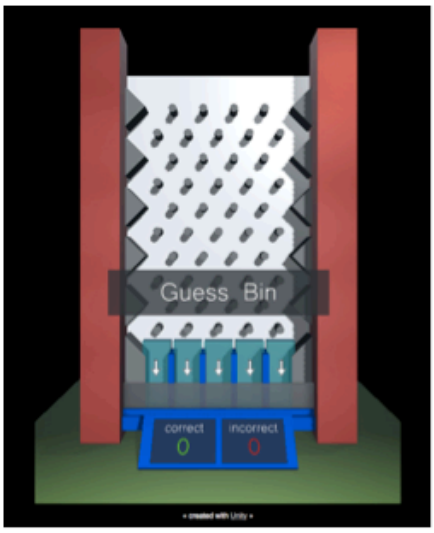
9. Other kids are usually more sure about things than I am.

   0 1 2 3 4

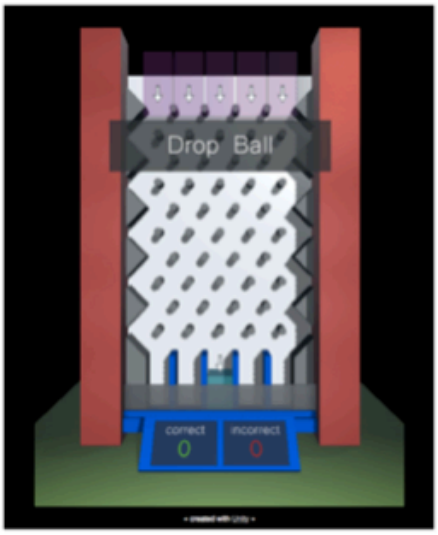
10. I get worried when things confuse me.

    0 1 2 3 4

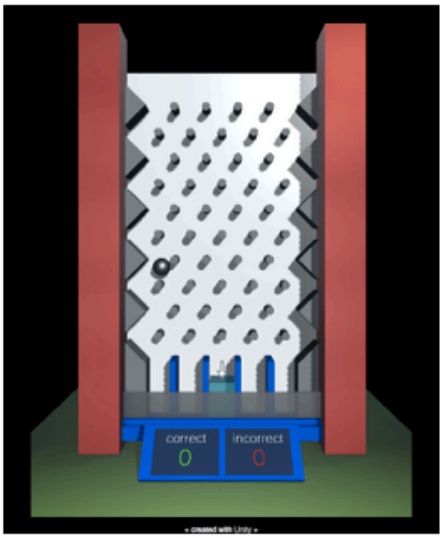
Appendix B: Plinko Screenshots



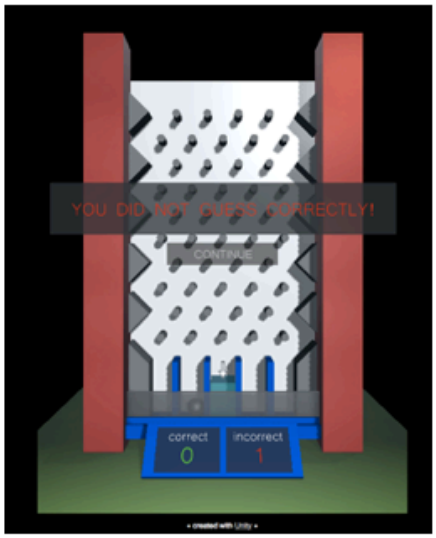
a) player is prompted to guess in which bin the ball will land



b) player is prompted to select a slot from which to drop the ball



c) player watches the ball travel down the pegboard



d) player is notified whether guess was correct or incorrect

Appendix C: Examples of Stimuli Used for Object Detection Task

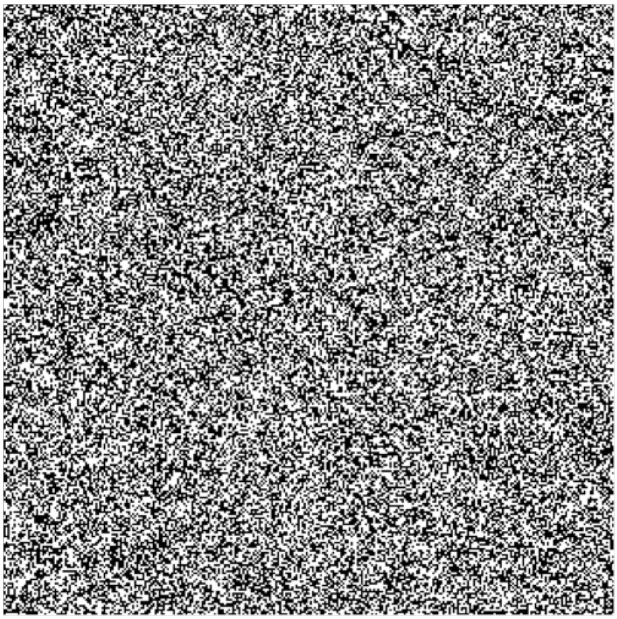


Image 1 (no object embedded)

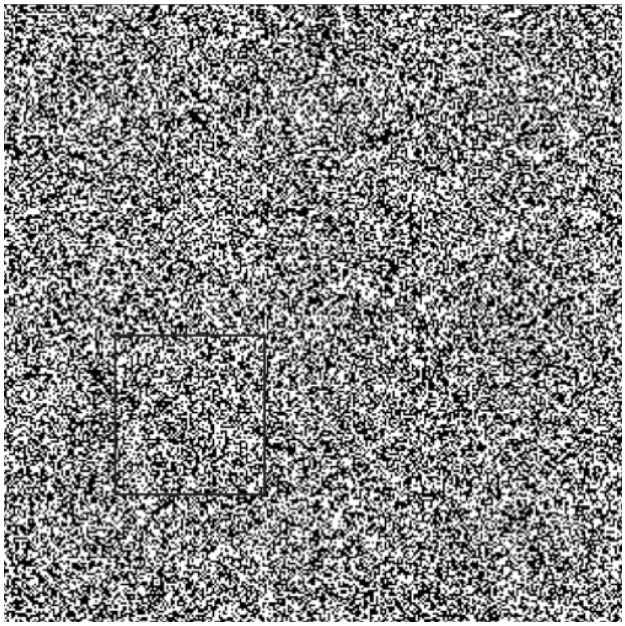


Image 7 (square embedded)

Appendix D: Experiment Script for Introduction and Practice Items

Thanks for agreeing to help me out today! While you're here, we're going to do a few different things. First, I'm just going to ask you some questions to get to know you. Then, I'm going to let you try out a new computer game and you can tell me what you think about it.

For Study 1: And finally, I'm going to show you some pictures and we'll talk about them. Sound good?

For Study 2: And finally, I'm going to tell you about some kids and some things that happened to them, and we'll talk about that. Sound good?

Okay, so the first thing I'm going to do is read you some sentences, and I want you to tell me how much you agree with each one. You can tell me your answer by pointing to one of these numbers. (*direct attention to laminated number line*)

You'll point to 0 if you *do not agree at all* with the sentence; point to 1 if you only *agree a little bit*; point to 2 if you *agree some*; point to 3 if you *agree a lot*; and point to 4 if you *agree all the way*.

Let's practice using this number scale for a couple of sentences, okay? Here's the first practice sentence:

> I think that vegetables taste better than fruit. Show me how much you agree with that sentence. (*point to numbers while reading each of the options*) Do you not at all agree, do you agree a little bit, do you agree some, do you agree a lot, or do you agree all the way that vegetables taste better than fruit?
>
> 0 1 2 3 4
>
> Okay. The next sentence is: It bothers me when I see someone being mean to their little brother. Show me how much you agree with that sentence.
>
> 0 1 2 3 4
>
> The last practice sentence is: I like it when things scare me. Show me how much you agree with that.
>
> 0 1 2 3 4

Alright, great! I have a few more sentences for you, and I want you to continue pointing to these numbers to show me how much you agree with them. Don't worry – there aren't any right or wrong answers. Everybody has different ideas, and I just want to know what *you* think. Okay?

Appendix E: Story Task

Superstitious Stories

Positive Outcome:

Whenever Carol really wants something, she spins around in a circle and counts to 10. The other day, when Carol was at the music store, she saw people entering their names for a contest. Carol entered her name in the contest, and then she spun around in a circle and counted to 10. A couple of days later, the music store called Carol and told her that she was the winner of the contest!

How much do you think that happened because she spun around in a circle and counted to 10?

Negative Outcome:

Whenever Billy goes to the library, he always finds the book that he wants to check out. And every time he goes to the library, Billy taps his foot three times before he walks inside. The other day, Billy was running late and he forgot to tap his foot three times before walking into the library. When he went to look for the library book that he really wanted to check out, the librarian told him it was already checked out by someone else!

How much do you think that happened because he didn't tap his foot three times before going into the library?

Lucky Charms Stories

Positive Outcome:

Nick likes to play sports with his friends, and he always wears his special socks whenever he plays sports. This year, Nick's friend decided to have a birthday party at the bowling alley. Nick was nervous about the party, because he didn't know how to bowl and he didn't want to be the worst bowler there. Nick decided that he would wear his special socks to the bowling alley. At the party, he bowled better than all the other kids!

How much do you think that happened because he wore his special socks?

Negative Outcome:

Sarah is a good student who does well on her tests. Every time that Sarah knows she is going to have a test at school, she wears her favorite necklace. One day, Sarah went to school and had to take a test, but she realized that she had forgotten to wear her favorite necklace! When Sarah got her test back, she found out that she got a really bad grade on the test.

How much do you think that happened because she forgot to wear her favorite necklace?

Karma Stories

Positive Outcome:

Julie likes to help her community, so she volunteers at the animal hospital each Wednesday after school. She really enjoys taking care of the animals, even when they are sick. One day, when Julie was walking home, she found $100 bill on the sidewalk!

How much do you think that happened because she helped at the animal hospital?

Negative Outcome:

Stephen thinks it is fun to pick on the other kids in his class and make up lies about them. He knows it hurts their feelings, but he does it anyway. One day, Stephen made up a lie about someone else in his class and told that lie to all the other students. When Stephen was biking home from school that day, he got in a bike wreck and broke both of his arms!

How much do you think that happened because he told the lie at school?

Table 1: Intercorrelations among Items on the Intolerance of Uncertainty Scale in Study 1

	1	2	3	4	5	6	7	8	9	10
1. It really bothers me when I'm not sure about things.	_									
2. I worry a lot about what's going to happen in the future.	.16	_								
3. Sometimes I can't make up my mind, and that frustrates me.	.32*	.04	_							
4. I like going to new places where I don't know what's going to happen.	-.14	-.14	.10	_						
5. I always like to know my plans for the next day.	-.08	.23	-.10	.28*	_					
6. It's okay if I'm not sure about things.	.02	-.08	.15	.05	-.02	_				
7. I always think ahead so that I don't get surprised.	-.10	.11	.06	-.04	.17	.08	_			
8. I wish we could always know what's going to happen in the future.	-.22	.15	-.05	-.17	.17	.04	.12	_		
9. Other kids are usually more sure about things that I am.	-.19	.29*	.10	-.13	.08	-.06	-.01	.22	_	
10. I get worried when things confuse me.	.27	.39**	.14	-.11	.09	-.02	.01	.01	.16	_

* $p < .05$
** $p < .01$

Table 2: Intercorrelations among Items on the Intolerance of Uncertainty Scale in Study 2

	1	2	3	4	5	6	7	8	9	10
1. It really bothers me when I'm not sure about things.	_									
2. I worry a lot about what's going to happen in the future.	.24	_								
3. Sometimes I can't make up my mind, and that frustrates me.	.23	.15	_							
4. I like going to new places where I don't know what's going to happen.	-.01	.40**	.02	_						
5. I always like to know my plans for the next day.	.45**	.37**	.03	.16	_					
6. It's okay if I'm not sure about things.	.21	.06	.17	.19	.09	_				
7. I always think ahead so that I don't get surprised.	.06	.10	.16	-.02	.40**	.08	_			
8. I wish we could always know what's going to happen in the future.	.33*	.12	.11	-.04	.46**	.13	.29*	_		
9. Other kids are usually more sure about things that I am.	.08	.19	.16	-.15	.13	.02	.27	.14	_	
10. I get worried when things confuse me.	.19	.39**	.24	.05	.23	.27	.35*	.21	.18	_

* $p < .05$
** $p < .01$

Figure 1: Number of objects detected as a function of age (Study 1)

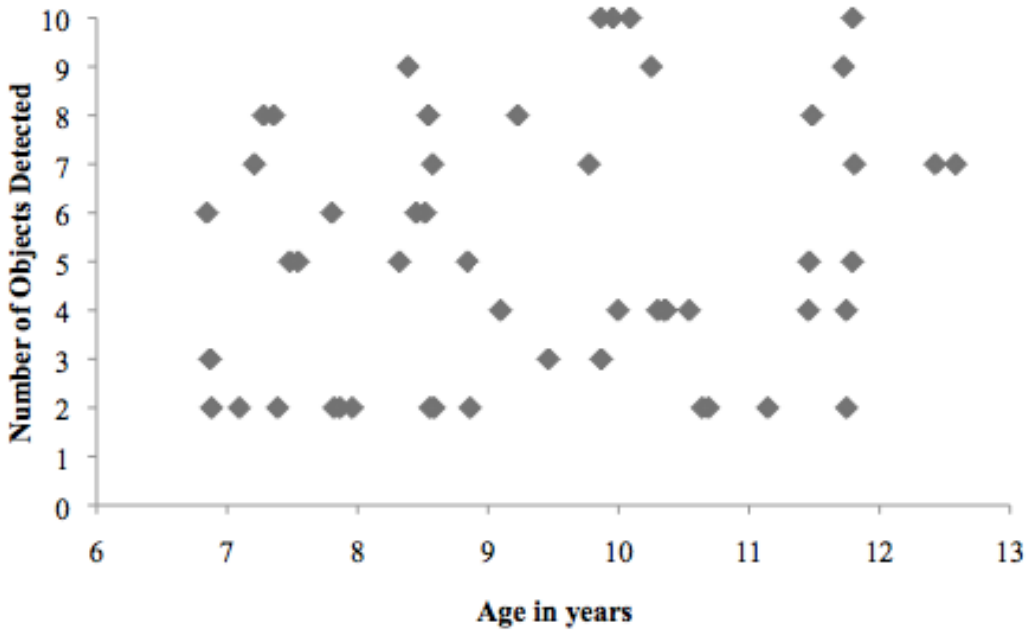


Figure 2: Intolerance of uncertainty scores as a function of age (Study 2)

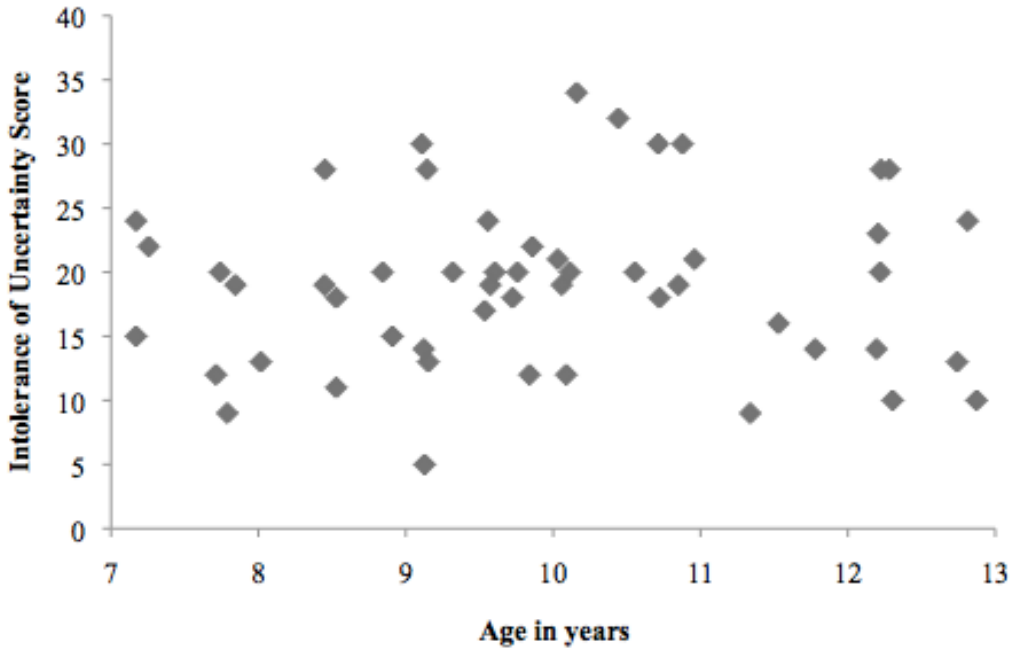
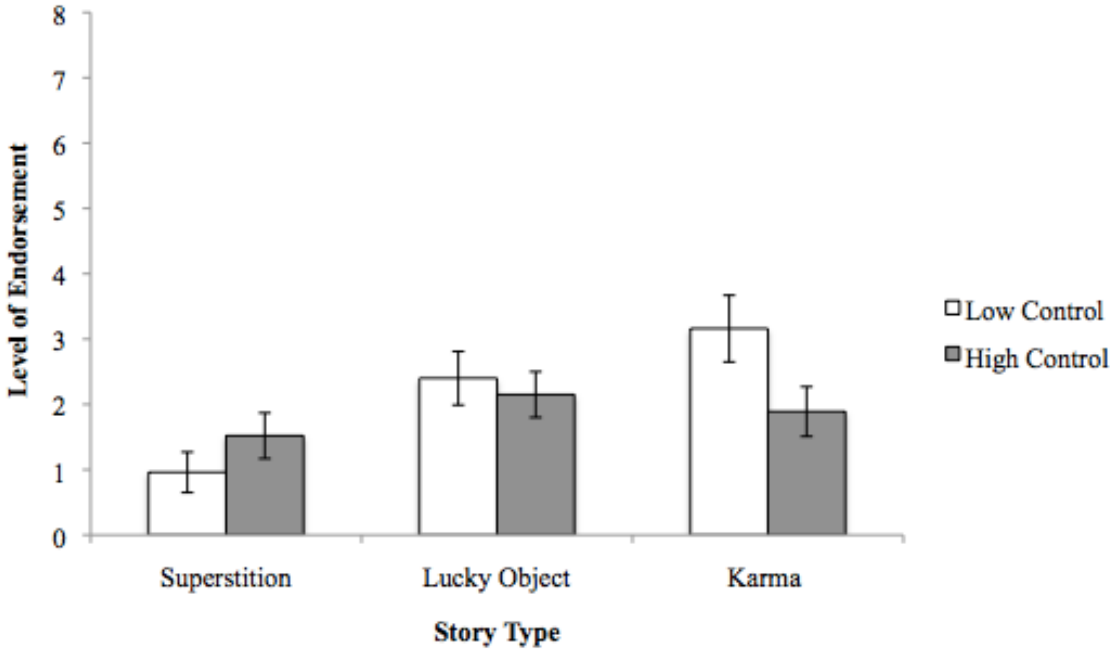
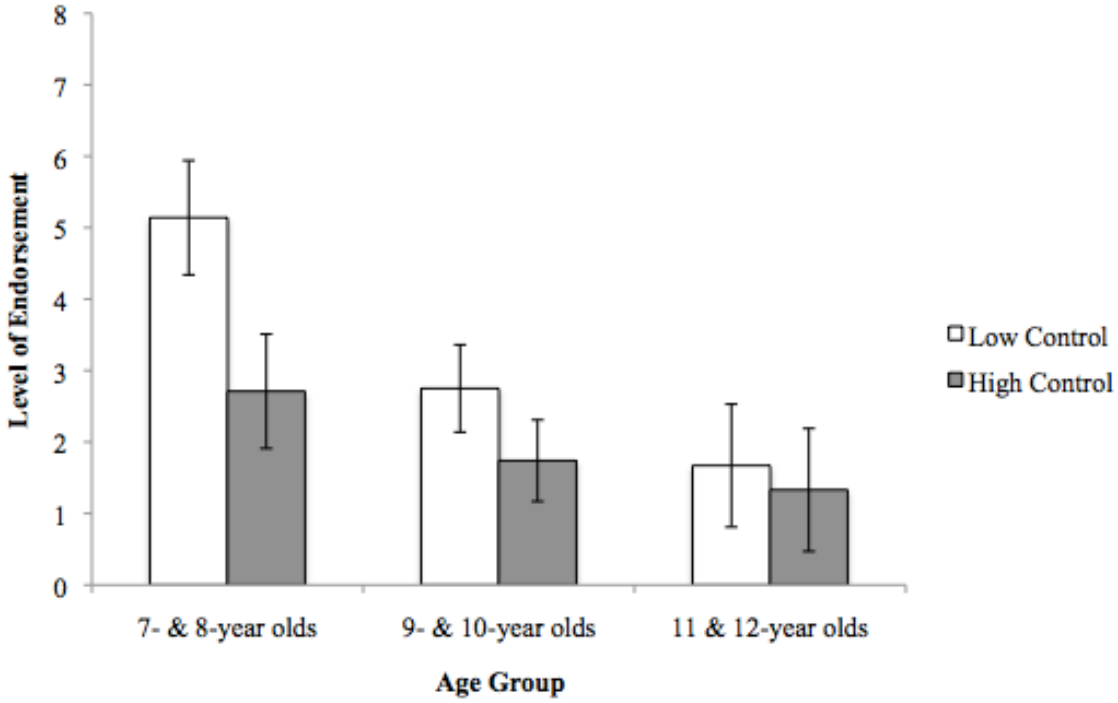


Figure 3: Effect of condition on endorsement of explanations in the story task



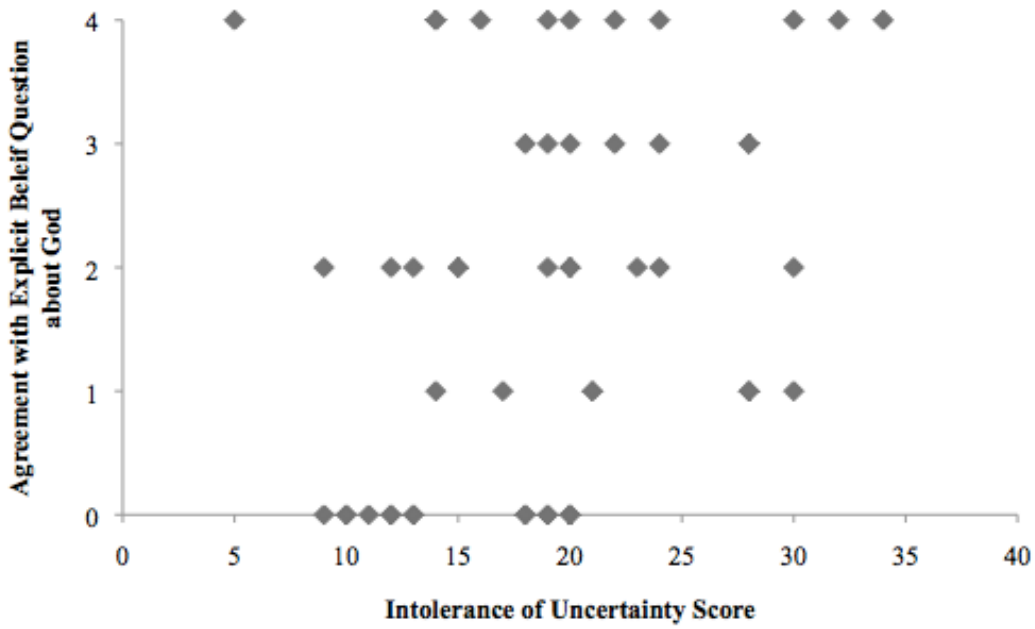
Participants heard 2 stories of each story type and rated their agreement with the explanation on a scale from 0 (not at all) to 4 (all the way). Error bars denote standard error of the mean.

Figure 4: Main effects of age group and condition on endorsement of explanations for the karma stories



Participants heard 2 stories and rated their agreement with the explanation on a scale from 0 (not at all) to 4 (all the way). Error bars denote standard error of the mean.

Figure 5. Relationship between scores on the intolerance of uncertainty scale and agreement with the explicit belief question about God.



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